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may become unstable. There is a running down of a part of the intrinsic energy of one or both of the substances into heat, light or electricity but almost always largely into heat; and the substances rearrange themselves into those new combinations which are most stable under the new conditions.

This is what we ordinarily describe as a chemical reaction, and this can be taught to any sensible student just as well as the elements of physics can be taught to him.

Finally, the matters herein referred to, together with many others which time will not permit me even to mention, can not, of course, be taught the beginner all at once, in addition to the so-called material facts of chemistry. It is, however, a fair question to ask whether some of these matters would not be a fair substitute for a part of the pyrotechnics that sometimes adorns the chemical lecture table?

In all such matters the judgment and common sense of the teacher must of course be the final guide, and the intellectual fiber of the student must also be taken into account. It goes without saying that we must not teach dogmatically anything to the student of chemistry, much less to the beginner in chemistry, that is not reasonably substantiated; but I believe that all of the matters referred to above and many more of their type belong in this class.

The final question then is, shall we have two chemistries or one? Shall we have a chemistry of research, pushing forward at a pace that makes the last twenty-five years mark a distinctly new epoch in the history of the science? and another chemistry taught the beginner, which practically ignores all that has been done within that period; which deals not only with what is obsolete, but with what we know to be largely untrue, and which relies upon subsequent teaching to do almost the impossible, *i. e.*, correct erroneous first impressions, which must in some method be corrected, or the result is fatal?

Or shall we have one science of chemistry? Research leading the way, and teaching following fairly closely behind? At least doing

nothing that will have to be undone, but incorporating what is truest and best.

For those who believe as I do that the latter is the more scientific course, there is not only no ground for pessimism, but not even for pragmatic meliorism.

The progress in this direction during the last decade, not only in the better colleges and universities, but in the more progressive high schools, has been so rapid that there is room for nothing but the most cheerful optimism.

HARRY C. JONES

IS SCIENCE REALLY UNPOPULAR IN HIGH SCHOOLS?

THE period covered by the tenth decade of the nineteenth century and the first of the twentieth was one of great activity in the reconstruction of high school schedules. The reports of the N. E. A., Committees of Ten and on college entrance examinations, the formation of the College Entrance Examination Board, the Perry and other movements for the reform and unification of science and mathematical teaching, all must have influenced high school curricula, and the alterations of the curricula must have shown effects in the percentages of secondary students in the various courses.

The famous attack made by President G. Stanley Hall¹ on the methods and attitude of secondary teaching in the United States was based to a certain extent on the summary tables of the percentage of secondary students in the United States taking the various high school studies, and published in the reports of the Commissioner of Education, 1890 to 1907. In order to exhibit these I have plotted the data on a chart. The curves for studies, graduates and college preparatory students are from the summary table (p. 1052), Report of the Commissioner of Education for 1907; that for per cent. of secondary students

¹G. Stanley Hall, "How Far is the Present High School and Early College Training adapted to the Needs and Nature of Adolescents?" N. E. Asso. Coll. and Prep. Schs., 16, p. 72, 1901; *Ped. Sem.*, 9, p. 92, 1902; *Sch. Rev.*, 9, p. 649, 1901.

in the total population, from table on p. 1044. No curves are plotted for trigonometry and psychology, as they have never been of appreciable importance as high-school studies; the curves for Greek and geology are omitted, as they so nearly coincide with that for astronomy as to cause confusion.

Certain facts stand out from the curve-sheet. Greek has declined; so has civics; Latin, modern languages, English literature, rhetoric and foreign history have all increased, some of them enormously; *all the natural sciences* have fallen—geology, astronomy, chemistry, physics, physical geography and physiology have all dropped down, some of them enormously. Meanwhile the percentage of graduates has increased—a good showing, indicating that students are better satisfied with the schools than they were formerly—the proportion of students preparing for college has diminished, and the proportion of secondary students to total population has nearly doubled.

It is well known that the proportion of secondary students in the earlier years of the course is greater than that later. Hence a possible cause of an observed diminution in popularity of a subject is the alteration of schedules so as to shift the study into the later years of the course, and *vice versa* for an increase of popularity. Then the remarkable growth of the elective system, which occurred largely in the period covered by these curves, and the actual withdrawal of courses, are other causes which would affect the percentages. Now if we can in any way numerically express the opportunity which the average student has to take a given study, and compare with this the amount to which he takes advantage of his opportunity, as expressed in the tables of the bureau, we have in the ratio a numerical measure of the popularity of the study. I hope to be able to do this in a rough way from data already published, and to show that the drift away from science is in part at least the result of schedule tinkering, and does not completely express the taste of that much-criticized phenomenon, the rising generation.

If we can find the probability that a student selected at random from the mass shall be in any particular year of the high school course, and also the probability that a particular subject shall be offered by his school in that year, then the probability that this randomly selected student shall be taking this subject in this year is the product of these two probabilities, on the supposition that the subject is *required of all students* in this year. And this probability is also the percentage of students in the great mass who would be taking this subject in this year under the same supposition of no election.

The first probability is given by the Commissioner of Education in the Report for 1907, p. 1046, where it is said:

For several years this bureau has estimated the proportion of secondary students in each of the four years as 43 per cent. in the first year, 26 per cent. in the second year, 18 per cent. in the third year and 13 per cent. in the fourth year. This estimate was based upon the enrollment of secondary students by grades in the high schools of a number of cities.

Two things show that this is not a constant distribution. First, the bureau has for three or four recent years collected data of this sort for the whole country, beginning with this report of 1907, and the figures do vary a fraction of a per cent. from these estimates. Second, the percentages for high-school graduates charted on the curve-sheet, show that the proportion of graduates in the high-school population has gradually increased, being 10.05 per cent. in 1889-90 and 11.87 per cent. in 1905-6. But in spite of this evident, though not very large, variation, we have no other means of getting at the facts, and will use these mean values as representing the probability of a randomly selected student's being in any particular year of the course.

The means for estimating the amount and effect of schedule tinkering is very incomplete. An article by Professor E. G. Dexter²

² E. G. Dexter, *Sch. Rev.*, 14, p. 254, 1906; "Ten Years' Influence of the Report of the Committee of Ten."

gives the only statistics available for this purpose, so far as I know. He collected the printed programs of schools for the period just preceding 1894, when the report of the Committee of Ten would not yet be effective, and for that ten years later, and compared the two. In his own words:

For the earlier portion of the study 80 schools were covered: 35 in the eastern section of the country, 25 in the middle west and 10 each in the south and far west. For the period a decade later the number of schools was 160: 49 being in the east, 46 in the middle west, 30 in the south and 35 in the far west.

Neither these numbers nor the particular schools studied were the result of arbitrary choice, but in most cases of dire necessity. Every available course of study for the years 1892 to 1894 was considered, and this was essentially true for the period ten years later. So far as possible, the same schools were considered at both periods; but, as indicated by the figures, many more schools were included in the later than in the earlier study. This was that errors due to accidental conditions might be reduced to a minimum. I have not thought it necessary in this paper to give the names of the particular schools studied, but will say that the list includes the high schools of nearly all the larger cities of the country; and that none of the smallest schools are covered is suggested by the fact that only those issuing printed courses of study are included. The part of the study covered by this paper has to do only with those recommendations of the special subcommittees (of the Committee of Ten) which bear upon the high-school curriculum.

The second factor, the probability that the student will have the opportunity to take a study in the year in which he happens to be, can in most cases be computed from Dexter's data, in an approximate sort of way. I will give the computation for German in some detail, as in it appear all the irregularities which show themselves in connection with other subjects, and further, the resulting table contains the only essential absurdity which developed in the preliminary computations.

First, Dexter's table for German.

TABLE I

	1894	1904
Percentage of schools offering 2 years	34	25
Percentage of schools offering 3 years	33	36
Percentage of schools offering 4 years	33	23
Percentage beginning in the first high-school year or earlier	48	47
Percentage beginning in the second high-school year	30	41
Percentage beginning in the third high-school year	22	12

(I infer that 16 per cent. gave a 1-year course in 1904, beginning in year III.)

This table I rearrange and extend as follows:

TABLE II

	1894				1904		
	Begin	Per Cent.	Length		Begin	Per Cent.	Length
I.	48	33	4	I.	47	23	4
		15	3			24	3
II.	30	18	3	II.	41	12	3
		12	2			29	2
III.	22	22	2	III.	12	-4	2
		0	1			16	1
IV.	0	0	0	IV.	0	0	0

The percentages opposite the half-braces ({}) mean thus: For 1904 23 per cent. of the schools gave a 4-year course, while 47 per cent. began in year I.; hence 24 per cent. must begin a 3-year course in year I. Thirty-six per cent. gave a 3-year course, hence 12 per cent. begin the 3-year course in year II., etc. That this course of reasoning is imperfect appears from the fact that according to it —4 per cent. begin a 2-year course in year III., which is absurd. However, the difficulty lies in the original data being out of reach, and as the absurdity is not going to be of great influence on the computations, as it comes in the third and fourth years, I use the figures as they stand. The table for German is the only one in which any patent absurdity shows itself.

From this table I obtain the percentages which express the random student's opportunity to take German, *i. e.*, the per cent. of students who would be taking German were it required wherever and whenever it is offered, thus:

The probability that a student be in the first year of the course is 0.43, from the data of the Bureau of Education; the probability that German will be offered in that year is (1904) 0.23 for a 4-year course and 0.24 for a 3-year course, or 0.47 for both; the desired probability is then $0.43 \times 0.47 = 0.202$.³ The probability that a student be in the second year is 0.26; the probability that German will be offered in that year is 0.29 for a 2-year course begun that year, 0.24 for a 3-year course begun in first year, 0.23 for a 4-year course, 0.12 for a 3-year course begun in second year. The resulting probability that a student be taking German, if it were a required study in second year, is 0.26 ($0.29 + 0.24 + 0.23 + 0.12$) = 0.232. Similarly for the other years. Then the total probability that a random student be taking German in 1904 is 0.654. Computations like this carried out for the studies in Dexter's tables result in the following table.

With regard to some of the other subjects tabulated by the Bureau of Education, I am not able to draw any conclusions from Dexter's tables and other data. Some of his facts may be quoted as supplementing the table above.

This goes far to explain the increase in the percentage of students studying foreign history, as tabulated in the commissioned report and shown on the curve-sheet.

Table III., in spite of the very inadequate data on which it is in part based, is capable of giving us a certain amount of information about the relations between election and schedule alteration and the data of the Bureau of Education. The columns headed "per cent.—if required" give in per cents. the probabilities for each study that a random student would be taking the subject if there were no elective system, as derived from Dexter's data, and hence also the percentages of students in the mass who would take the sub-

TABLE III⁴

Study	Per Cent.—if Required			Per Cent.—Actual			Actual	
	1894	1904	Ratio	1894	1904	Ratio	Required	
							1894	1904
Latin.....	69.2	91.4	1.32	43.59	49.96	1.23	0.63	0.55
French.....	64.8	66.0	1.02	10.31	11.15	1.08	0.16	0.17
German.....	72.0	65.4	0.91	12.78	18.98	1.49	0.18	0.29
Algebra.....	47.7	53.1	1.11	52.71	56.23	1.07	1.10	1.06
Geometry, plane.....	24.2	30.4	1.26					
“ solid.....	8.0	10.5	1.31					
“ both.....	32.2	40.9	1.27	25.25	27.30	1.08	0.78	0.67
Physics.....	21.3	22.0	1.03	24.02	15.90	0.66	1.13	0.72
Chemistry.....	11.5	10.2	0.89	10.31	7.08	0.69	0.90	0.69
Geology.....	11.0	5.6	0.51	5.52 ⁵	2.79	0.51	0.50	0.50
Physical geography and physiography.....	29.8	27.0	0.91	22.44 ⁵	21.26	0.95	0.75	0.79

³ In this it is assumed that all schools dealt with are of the same size, which is inaccurate, but unavoidable.

⁴ Results computed from the articles of Hunter, Weckel, Ramsay and Whitney, published in *School Science and Mathematics* during the last two years, supplement the above table in part. But they depend on limited or fragmentary data. A complete census by the Bureau of Education would be of great value.

⁵ 1894-5 data.

ject under these conditions. In a way they measure the average opportunity for a student to take the subject. The column "ratio" gives the quotient of the per cent. for 1904 by that for 1894. It measures the extent of schedule change. The columns headed "per cent.—actual" are quoted from the commissioner's table. The "ratio" column is found in the same way. The columns headed "actual/required" check the accuracy

of the methods used, and show that in three places there are errors; for it is manifestly impossible that in 1894 or 1904 there could be more students taking algebra or physics than would take it were the subjects required. Besides, these columns tend in the clearest way to show the effect of the elective system; the ratios measure in a rough way the popularity of a study, when it is elective.

TABLE IV

Study	Per Cent. Schools Offering	
	1904	1904
Latin, four years	46	80
Physics	97	100
Chemistry, mostly in year III.	74	66
Astronomy	63	31
Physiology, mostly in years I. or II.	81	57
Trigonometry	23	44
English,* four years	52	68
English, less than four years, more than three years	12	32

For example: in spite of the great increase in the percentage of students taking Latin, the subject had in fact declined in popularity, as shown by the ratios, 1894, 0.63, 1904, 0.55; further, these ratios show that, after all, relatively few students took the subject in comparison with the opportunities.

TABLE V
The History Branches

	1894		1904	
	Per Cent. Offering	Length of Year	Per Cent. Offering	Length of Year
American	57	0.7	86	0.64
French	0	0.0	7	0.50
English	39	0.5	51	0.66
"Intensive"	0	0.0	5	1.00
Greek	47	0.5	57	0.50
Roman	50	0.5	57	0.50
General	46	1.0	61	1.00

Examining the table with this in view, we see that French has hardly changed, while German draws increasingly on the affections

*The separation into English literature and rhetoric or composition is not sharp, and is hard to tabulate.

of secondary students—may this be a reflex of the great influence of German thought in the universities, brought into the secondary schools by college-bred teachers? But both French and German have a low popularity, lower than any science. Algebra is the universal study, not generally elective, and so it is not surprising that its "popularity" should be represented by a number in the neighborhood of 1. The excess gives a rough idea of the errors inherent in my data, and the amount of guessing which has crept in. Geometry was in 1904 not so generally required as in 1894, and so shows a fall of popularity. Physics was in 1894 more generally required than in 1904, which accounts in part for the drop from about 1.00 to 0.72. The balance means real dislike for the subject. Geology and physical geography and physiography stay about where they were in popularity.

I am inclined to conclude from this table that, in spite of a general impression to the contrary, American boys and girls like the sciences, both exact and natural, better than they like the languages, *provided they only have as good a chance to get at them*; and the way to save the situation for science is to give them the chance early in the course. I assert with confidence that, had 80 per cent. of Dexter's schools in 1904 offered four years of chemistry and physics, instead of four years of Latin, as they did, we should have found the figures of percentages just about reversed, or even worse for Latin.

WILLARD J. FISHER

ITHACA, N. Y.,
December, 1911

*THE SMITHSONIAN BIOLOGICAL SURVEY
OF THE PANAMA CANAL ZONE*

THE Biological Survey of the Panama Canal Zone, begun in December, 1910, and continued through the major part of 1911, is being pushed to completion before the opening of the canal in 1913. The second expedition sailed on January 9, to take up the work for another season, the botanist, Professor